# MILLER CONSTRUCTION, INC.

P.O. BOX 86 ASCUTNEY BLVD WINDSOR, VERMONT 05089-0086
**TELEPHONE (802) 674-5525 / FAX (802) 674-5245**


## TRANSMITTAL

| TO: Jennifer Fitch, PE<br>Project Manager<br>Vermont Agency of Transportation | DATE | PROJECT NO. |
|---|---|---|
| | 6/10/2014 | Brookfield<br>BRF FLBR (2) |
| | | |

XX WE ENCLOSE THE FOLLOWING: _____ UNDER SEPARATE COVER WE ARE SENDING THE FOLLOWING

| COPIES | NUMBER | DESCRIPTION | CODE |
|---|---|---|---|
| 1 | | FRP Handling Calculations | H |
| 1 | | FRP Handling Drawings | H |
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CODE:

A FOR INITIAL APPROVAL
B FOR FINAL APPROVAL
C APPROVED AS NOTED-RESUBMISSION REQUIRED
D APPROVED AS NOTED-RESUBMISSION NOT REQUIRED
E DISAPPROVED-RESUBMIT
F QUOTATION REQUESTED
G APPROVED
H FOR APPROVAL
I AS REQUESTED OR REQUIRED
J FOR USE IN ERECTION
K LETTER FOLLOWS
L FOR FIELD CHECK
M FOR YOUR USE

BY: Paul J. Miller

# FRP Raft Pontoons – Lifting/Handling Supporting Comps

For

## Brookfield Floating Bridge

In

## Brookfield, Vermont

CEE 050-br-14 Vtrans BLF – FLBR(2)


Prepared for:

Miller Construction, Inc

By:
Kenway Corporation
June 8th, 2014

**Lifting and Handling**

*Bonded lift plate to lift from mold - adhesive shear*

| | | | |
|---|---|---|---|
| Estimated weight of assembly to be lifted out of mold = | 9,664 | lb | |
| Number of lift points for calculations = | 3 | | (actual = 4) |
| Load per lift point = | 3,221 | lb | |
| Design lift load (x3) = | 9,664 | lb | |

$$P_u \le \lambda\phi F_s A_s$$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $A_s$ = | 16 | $in^2$ | (bond area) | $\lambda$ = | 0.90 | | |
| $F_s$ = | 1.60 | ksi | (MA560 TDS) | $\phi$ = | 0.50 | | |
| $\lambda\phi F_s A_s$ = | 11,520 | lb | > | $P_u$ = | 9,664 | lb | |

*Bonded lift plate - shackle pin loading*

$$R_u = \lambda\phi R_n C_\Delta C_T$$

*Pin bearing*

$$R_{br} = t d_n F_L^{br}$$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| t = | 0.813 | in | (plate thk) | $\lambda$ = | 0.90 | | |
| $d_n$ = | 0.875 | in | (pin dia.) | $\phi$ = | 0.80 | | |
| $F_{br}$ = | 44.2 | ksi | (brng stren.) | $C_\Delta = C_T$ = | 1.0 | | |
| $\lambda\phi R_n$ = | 22,625 | lb | > | $R_u$ = | 9,664 | lb | (from above) |

*Net tension*

$$R_{nt} = \frac{1}{K_{nt,L}}\left(w - nd_n\right)tF_L^t$$

$$K_{nt,L} = C_L\left(S_{pr} - 1.5\frac{\left(S_{pr}-1\right)}{\left(S_{pr}+1\right)}\Theta\right) + 1$$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| t = | 0.813 | in | (plate thk) | n = | 1 | | |
| $d_n$ = | 0.938 | in | (dia. +1/16) | w = | 3.75 | | (4 x $e_{2,min}$) |
| $F_L$ = | 44.54 | ksi | (ten. stren.) | $e_1$ = | 2.50 | | |
| $C_L$ = | 0.40 | | | $K_{nt,L}$ = | 2.33 | | |
| $\lambda$ = | 0.90 | | | $S_{pr}$ = | 4.00 | | (w / $d_n$) |
| $\phi$ = | 0.50 | | | $\Theta$ = | 0.75 | | ($e_1$/w ≤ 1) |
| $C_\Delta = C_T$ = | 1.0 | | | | | | |
| $\lambda\phi R_n$ = | 19,657 | kip | > | $R_u$ = | 9,664 | lb | (from above) |

*Bonded lift plate - shear-out*

$$R_{sh} = 1.4\left(e_1 - \frac{d_n}{2}\right)tF_{sh}$$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| t = | 0.813 | in | (plate thk) | | | | |
| $d_n$ = | 0.938 | in | (dia. +1/16) | | | | |
| $F_{sh}$ = | 12.16 | ksi | (shear str.) | | | | |
| λ = | 0.90 | | | | $e_1$ = | 2.5 | in |
| ϕ = | 0.50 | | | | $C_\Delta = C_T$ = | 1.0 | |
| $\lambda\phi R_n$ = | 12,643 | lb | > | $R_u$ = | 9,664 | lb | (from above) |

*Bonded lift plate - cleavage*

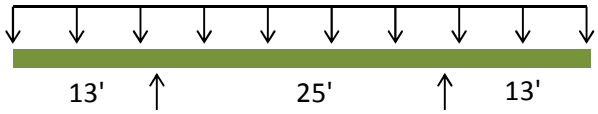
$$R_{cl} = 0.15\left((2e_2 - d_n)F_L^t + 2e_1F_{sh}\right)t$$ Eqn 1

$$R_{cl} = \left(\frac{10}{9} - \frac{4}{9}\frac{d_n}{e_1}\right)^2 R_{br}$$ Eqn 2

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| t = | 0.813 | in | (plate thk) | | | | |
| $d_n$ = | 0.938 | in | (dia. +1/16) | | $e_1$ = | 2.5 | in |
| $F_{sh}$ = | 12.16 | ksi | (shear str.) | | $e_2$ = | 2.00 | in |
| $F_{t,L}$ = | 44.54 | ksi | (tensile str.) | | λ = | 0.90 | |
| $C_\Delta = C_T$ = | 1.0 | | | | ϕ = | 0.50 | |
| Eqn 1 = | 24,034 | psi | | | Eqn 2 = | 28,029 | psi |
| $\lambda\phi R_n$ = | 12,613 | kip | > | $R_u$ = | 9,664 | kip | (from above) |

*Basket loading of a pontoon*

| | | | |
|---|---|---|---|
| Estimated weight of pontoon with hardware) = | 13,603 | lb | |
| Number of basket sling lift points = | 2 | | |
| Load per lift point = | 9,522 | lb | (Wt. / 2 x 1.4) |




| | | |
|---|---|---|
| Distributed load = | 266.7 | plf |
| Max moment (over supports) = | 22.54 | kip-ft |
| Ultimate moment capacity (Submittal 01 calculations) = | 7,212 | kip-ft |
| Transverse load applied by sling = | 9.5 | kip |
| Ultimate load capacity (Submittal 01 calculations) = | 347 | kip |

*Boat stand pad laoding*

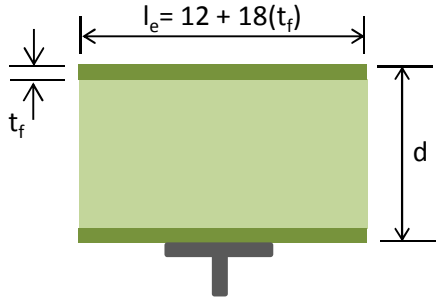
| | | | |
|---|---|---|---|
| Estimated weight of pontoon (with hardware) = | 13,603 | lb | |
| Number of boat stands = | 4 | | |
| Area of pad on each stand = | 144 | $in^2$ | (12 x 12) |
| Distributed load per pad = | 0.033 | ksi | (x 1.4) |
| Ultimate compression load capacity (compression) = | 29.67 | ksi | |

*Buckling of transverse bulkhead due to stand loading*

$$N_u^c \le \lambda \phi_c N_n^c$$

$$N_n^c = F^{cr} t$$

$$F^{cr} = \left(\frac{t}{b}\right)^2 \frac{\pi^2}{6}\left((4k_{cr} - 3)\sqrt{E_L E_T} + k_{cr} E_T \nu_{LT} + 2k_{cr} G_{LT}\right)$$

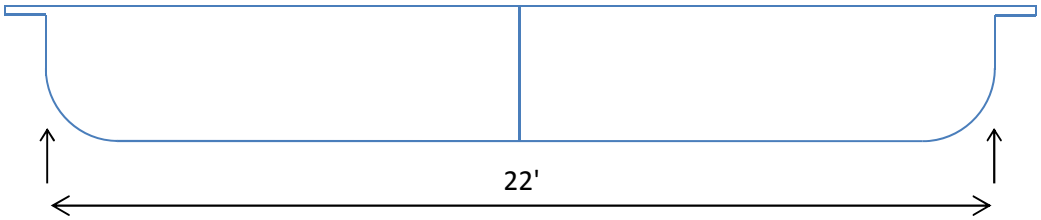



$$N_u = \frac{W_u}{l_e}$$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $F^{cr}$ = | 2.27 | ksi | | | | | |
| t = | 0.509 | in | | | | | |
| $E_L = E_T$ = | 3.11 | Msi | | | | | |
| $G_{LT}$ = | 0.67 | Msi | | | | | |
| $\nu_{LT}$ = | 0.20 | | | | | | |
| $\lambda$ = | 0.90 | | | | | | |
| $\phi$ = | 0.70 | | | d = | 35 | in | (unsupported height) |
| | | | | $W_u$ = | 4.76 | kip | (Wt. / 4 x 1.4) |
| $k_{cr}$ = | 1.1 | (1.0 (pin)→1.3 (fixed)) | | $l_e$ = | 21.2 | in | |
| $\lambda\phi_c N_n$ = | 0.73 | kip/in | > | $N_u$ = | 0.22 | kip/in | |

Pontoons will be removed from the flatbed trailer and set on sleepers on land where they will be aligned and post-tensioned. Two 14 ft spreader beams will be rigged to a central 25 ft spreader beam. Once the raft is assembled, two 25 ft spreader beams will be rigged to a central 25 ft spreader beam for lifting the raft into the water. The rafts will be joined in the water where no load is placed on the joints during bolting or when moving out to accmomdate the next raft. An anchoring system will be used to keep the sections aligned. A diver will be used to torque bolts in the bottom flange.

*Stresses between pontoons when basket loading raft*



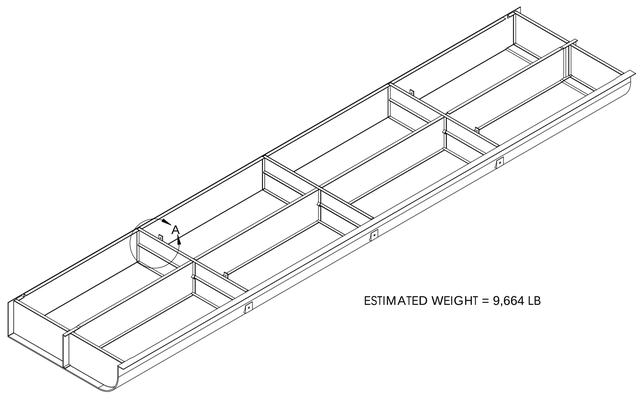

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| w = | 1,237 | lb/ft | (=27,206 lb / 22') | | | | |
| $l$ = | 22.0 | ft | | P = | 50,000 | lb/rod | (post ten.) |
| $M_{max}$ = | 74.8 | kip-ft | ($wl^2/8$) | | | | |

Cross section between pontoons is symmetric (about z-axis in yz-plane) so neutral axis is at 18 in. above baseline.

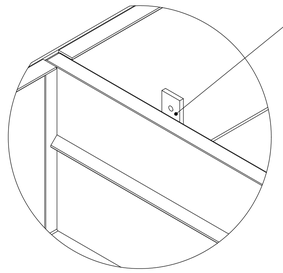
*Compressive stress in top plate*

$$N_u^c \le \lambda \phi_c N_n^c \qquad N_n^c = F^c t \qquad N_u = \sigma t$$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $F_c$ = | 29.67 | ksi | | $M_u$ = | 104.7 | kip-ft | (74.8 x 1.4) |
| t = | 0.509 | in | | y = | 17.75 | in | (N.A. to midplane) |
| $\lambda$ = | 0.90 | | | d = | 35.49 | in | (2 x y) |
| $\phi$ = | 0.70 | | | C = | 2.95 | kip | (M / d) |
| $\lambda\phi_c N_n$ = | 9.5 | kip/in | > | $N_u$ = | 0.25 | kip/in | ((C + 3P) / 51') |

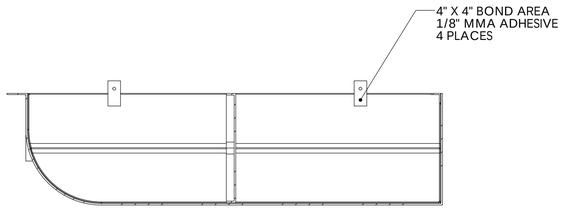



ESTIMATED WEIGHT = 9,664 LB



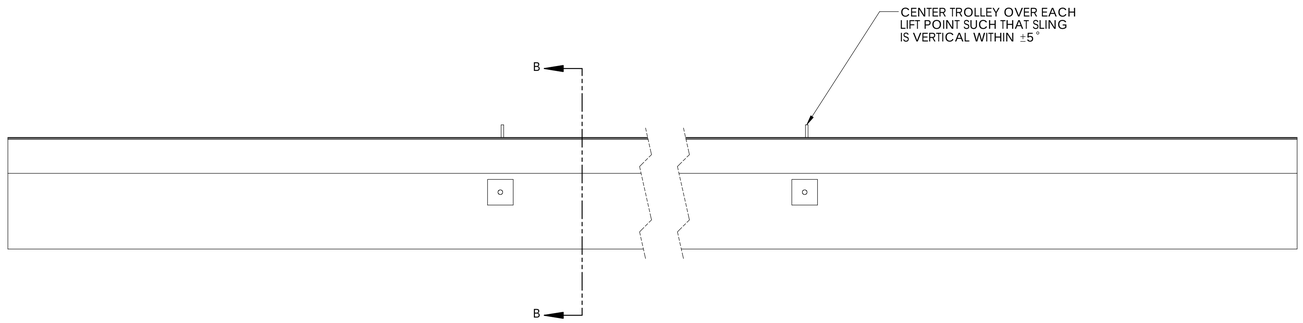

DETAIL A
SCALE 1 : 12

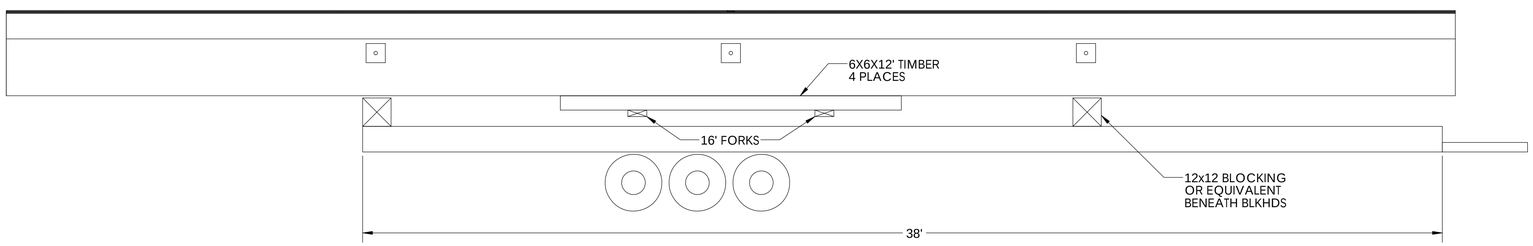
# LIFTING ARRANGEMENT FOR DEMOLDING ASSEMBLY




SECTION B-B

SCALE 1 : 24




BOAT TRAILER WILL BE USED TO HAUL PONTOON OUT OF BUILDING TO STAGING AREA

DUAL BRIDGE CRANES WILL HOIST PONTOON PER SKETCH ON SHEET 2

18,000 LB HYSTER FORKLIFT WILL PICK PONTOON FROM TRAILER AND SET ON BOAT STANDS

KENWAY CORP.

| REV | DESCRIPTION | DATE |
|---|---|---|

SEAL

DIMENSIONS ARE IN INCHES
TOLERANCES: FRACTIONAL ± 0, -1/16"
ANGULAR: MACH ± BEND ± 1°
TWO PLACE DECIMAL ± .1
THREE PLACE DECIMAL ± .01

| DRAWN BY | DATE |
|---|---|
| JM | 5/20/14 |
| CHKD BY | DATE |
| XX | X/X/XX |

PROJECT: BROOKFIELD FRP PONTOONS

CUSTOMER: MILLER CONST. / VTRANS

SHEET: PONTTON LIFTING AND HANDLING DURING FABRICATION

WEIGHT: N/A

DESCRIPTION: DESIGN DWG

SCALE 1 : 32

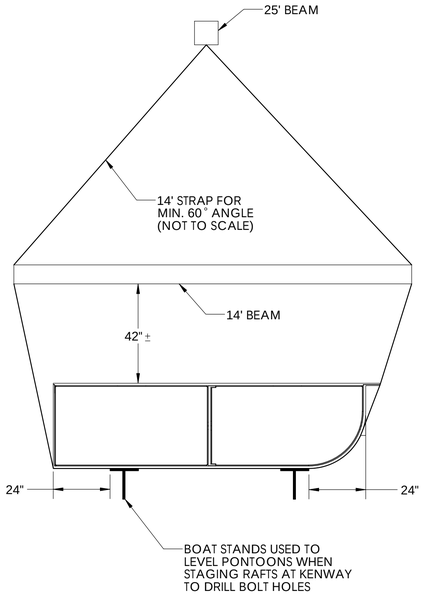
WO NO. 8420

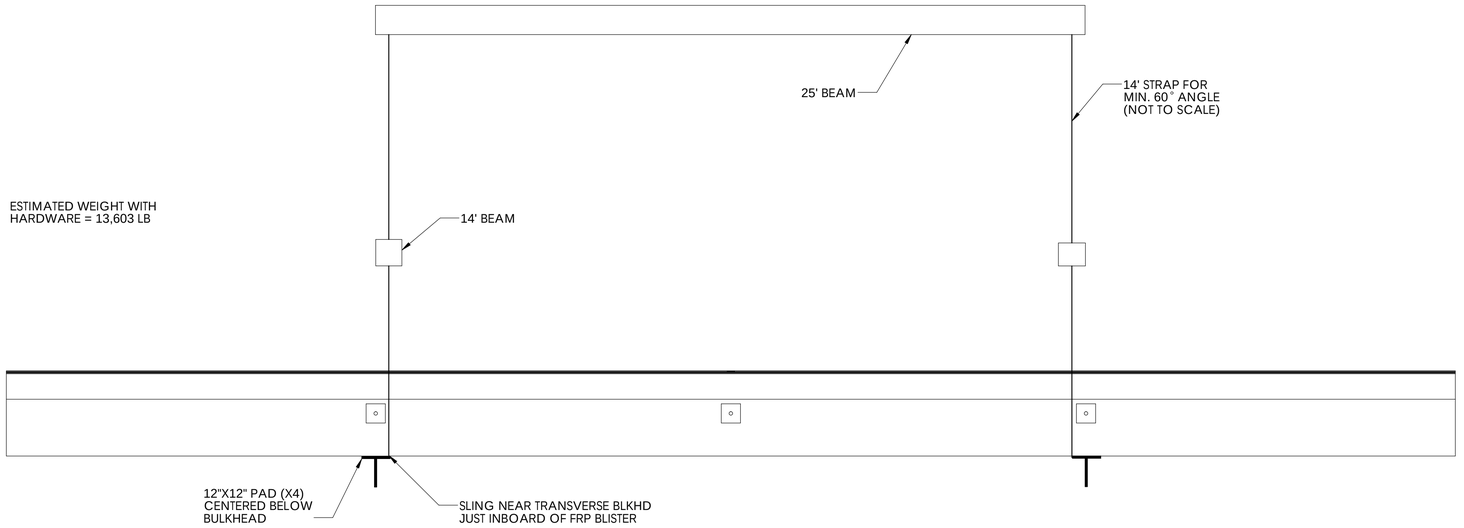
CONTRACT NO. 9185

DWG NO. 8420-2

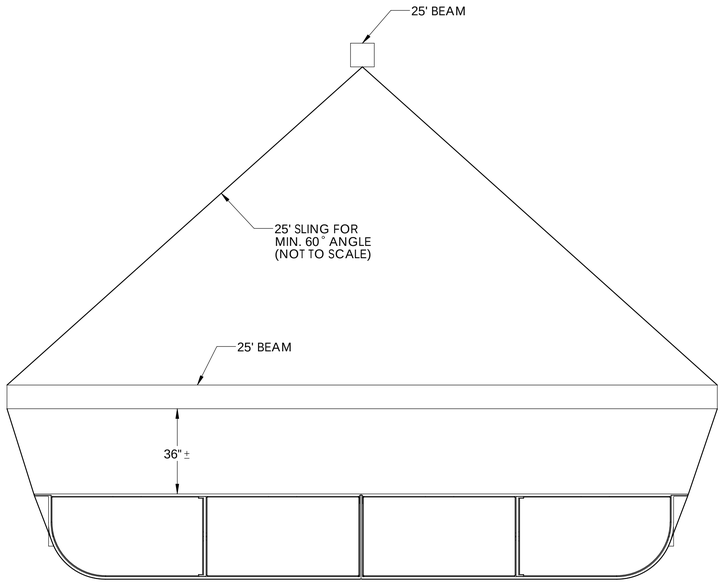
SHEET 1 OF 2

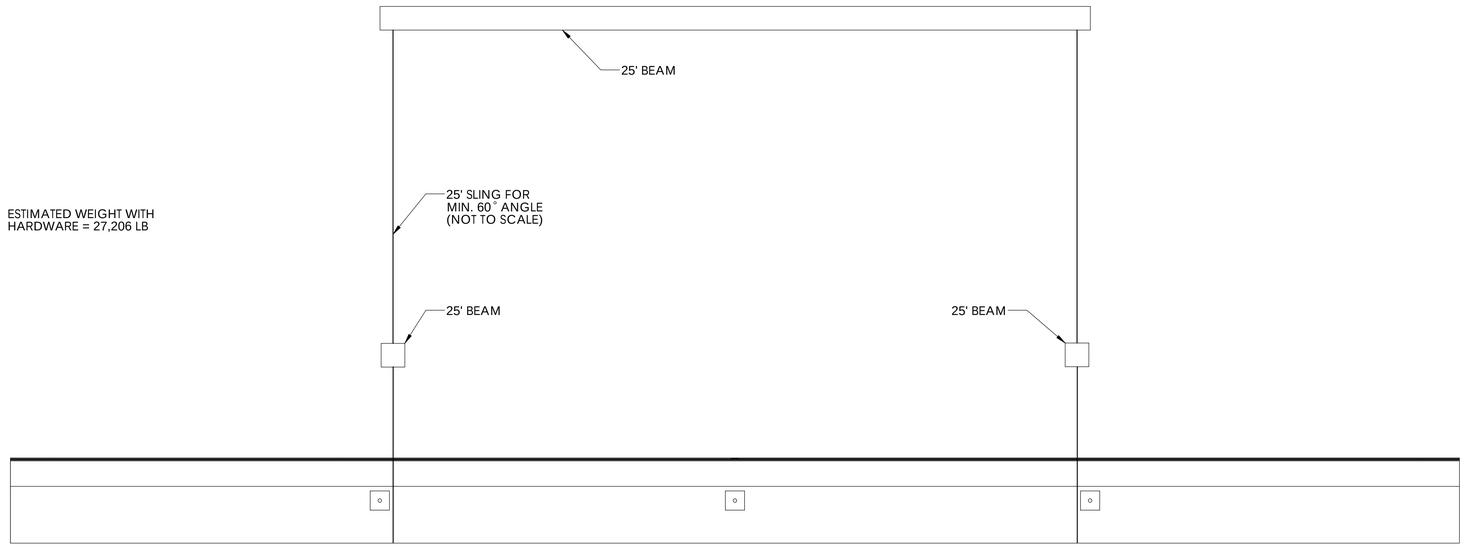
| PONTOON | PART NO. |
|---|---|
| N/A | N/A |




PONTTON LIFTING PLAN




RAFT LIFTING PLAN

KENWAY CORP.

| REV | DESCRIPTION | DATE |
|---|---|---|
| | | |

SEAL

DIMENSIONS ARE IN INCHES
TOLERANCES: FRACTIONAL ± 0, ± 1/16"
ANGULAR: MACH ± BEND ± 1°
TWO PLACE DECIMAL ± .1
THREE PLACE DECIMAL ± .1

| DRAWN BY | DATE |
|---|---|
| JM | 5/20/14 |
| CHKD BY | DATE |
| XX | X/X/XX |

PROJECT: BROOKFIELD FRP PONTOONS

CUSTOMER: MILLER CONST. / VTRANS

SHEET: PONTOON AND RAFT LIFTING AND HANDLING ARRANGEMENTS

WEIGHT: N/A

DESCRIPTION: DESIGN DWG

SCALE 1 : 32

WO NO. 8420

CONTRACT NO. 9185

DWG NO. 8420-1

SHEET 2 OF 2

| PONTOON | PART NO. |
|---|---|
| N/A | N/A |